Non-Stabilizerness of Sachdev-Ye-Kitaev Model

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Abstract

We study the non-stabilizerness or quantum magic of the Sachdev-Ye-Kitaev (SYK) model, a prototype example of maximally chaotic quantum matter. We show that the Majorana spectrum of its ground state, encoding the spreading of the state in the Majorana basis, displays a Gaussian distribution as expected for chaotic quantum many-body systems. We compare our results with the case of the SYK_2 model, describing non-chaotic random free fermions, and show that the Majorana spectrum is qualitatively different in the two cases, featuring an exponential Laplace distribution for the SYK_2 model rather than a Gaussian. From the spectrum we extract the Stabilizer Renyi Entropy (SRE) and show that for both models it displays a linear scaling with system size, with a prefactor that is larger for the SYK model, which has therefore higher magic. Finally, we discuss the spreading of quantun magic under unitary dynamics, as described by the evolution of the Majorana spectrum and the Stabilizer Renyi Entropy starting from a stabilizer state. We show that the SRE for the SYK_2 model equilibrates rapidly, but that in the steady-state the interacting chaotic SYK model has more magic than the simple SYK_2. Our results therefore suggest that non-stabilizerness allows to sharply detect many-body quantum chaos.

[1]. Surajit Bera, and Marco Schiro. **Non-Stabilizerness of Sachdev-Ye-Kitaev Model(arXiv:2502.01582)**